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ABSTRACT

This paper defines and clarifies aspects of the problem of measuring the outputs and objectives of higher education. The author proposes some standard terminology and introduces in a relatively unstructured way some ideas which may stimulate more systematic and critical thinking on the problem of measures of outputs and objectives. The attention of the paper is confined to the question of measures for the instructional process. Definitions of the concepts of effectiveness, outputs, benefits and efficiency and value-added are posted. They, using these definitions, the author describes an analytic comparison system for measuring instructional efficiency. First, he examines the question of total costs and total benefits which result from instruction in a particular field in a given institution among degree programs at various levels. He then postulates an second level of comparison concerning degree work at a given level within a given institution but covering different fields. Analysis of this sort might reveal a determinable relationship between resources invested and quality of output. The form of this relationship would be of considerable interest in that institutions would have some rough idea of the cost of changing their output quality indices. (Author)

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HIGHER EDUCATION OBJECTIVES: MEASURES OF PERFORMANCE AND EFFECTIVENESS

John E. Keller

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TABLE OF CONTENTS

Page

PREFACE ii

INTRODUCTION. 1

INSTITUTIONS AND OBJECTIVE-ACHIEVEMENT. 1

THE INSTITUTIONAL PROCESS AND MEASURES OF OBJECTIVE ACHIEVEMENT . . . 4

Effectiveness. 5

Output 6

Benefits 7

Efficiency and the Notion of Value Added 8

AN ANALYTIC COMPARISON SYSTEM FOR MEASURING INSTRUCTIONAL EFFICIENCY 12

CONCLUSION. 15

PREFACE

This is one of a continuing series of reports of the Ford Foundation sponsored Research Program in University Administration at the University of California, Berkeley. The guiding purpose of this Program is to undertake quantitative research which will assist university administrators and other individuals seriously concerned with the management of university systems both to understand the basic functions of their complex systems and to utilize effectively the tools of modern management in the allocation of educational resources.

This paper was originally presented at a seminar entitled, "Management Information Systems: Their Development and Use in the Administration of Higher Education," sponsored by the Western Interstate Commission for Higher Education and the American Council on Education. It is reprinted with their permission.

INTRODUCTION

The purpose of this paper is to discuss the subject pretty much as indicated by the title. Some qualifications and limitations should be noted first, however. The paper in its present form represents essentially only the views and experience of the author as modified by contact with his professional colleagues (particularly Dr. F. E. Balderston, Professor Lewis Perl, Professor Robert Adams, and Mrs. Pauline Fong). It does not provide an organized review of the scholarly literature (if any exists) on this subject. Further, the aim here is no more ambitious than to attempt to define and clarify aspects of the problem, to propose some standard terminology, and to introduce in a relatively unstructured way some ideas and concepts which may stimulate more systematic and critical thinking on the problem of measures of output or effectiveness for higher education. Even more narrowly, the focus here will be almost exclusively on the instructional process and will largely ignore the more difficult problems of output measurement of research and public service activities of higher educational institutions.

INSTITUTIONS AND OBJECTIVE-ACHIEVEMENT

Universities and colleges, like all human institutions, are organized to achieve some purpose, i.e., they have objectives. (These, of course, are not necessarily unchanged by time and circumstances.) However, in order to have some idea of how well institutions are achieving their objectives they need some kind of a scale (hopefully quantifiable) by

which to measure the degree of their objective-achievement. Thus, even the narrowly defined interests of the organization would lead it to want to have indicators of effectiveness, output, or benefit simply as measures of how well it was achieving those goals which called it into existence in the first place.

Further, if the organization is at all resource-constrained--if it has insufficient resources to accomplish all of its objectives on the scale and with the quality it desires--then the question of efficiency must be faced. That is, it is again in the organization's own quite narrowly conceived interest to attempt to maximize the degree of its objective-achievement within whatever resources are made available. Another way of stating this is to say that all organizations need, in their own interests, to minimize the cost per unit of output.

Since all "real-world" organizations have virtually unlimited objectives as well as highly constrained resources, they all face this efficiency imperative. This in turn implies that they must be quite self-conscious and sophisticated in specifying their real objectives in developing mutually consistent and related sub-objectives which can be couched in quantifiable operational terms, in creating practical scales or indices which measure objective-achievement, in identifying all of the cost- and output-producing attributes of the alternatives available to them which tend to achieve the objectives, and in developing some formal mechanism for evaluating the alternatives and for choosing a preferred one or set. In short, the organization needs to bring to bear the highest possible level of professional skill on the problem of allocating its resources among the many competing activities (alternative programs) which face it. Thus, clear thinking and rational analysis are important conditions

for organizational success--if not survival.

An important biasing factor in specifying objectives is how the institution conceives of itself, that is, what role it believes it should fulfill. For a modern university there are several possible conceptualizations--recognizing, of course, that there is some overlapping among them. For example, a university can conceive of itself as a member of the knowledge industry. Viewed in that light its objectives could very well be defined as being: (a) the preservation of knowledge; (b) the transmission of knowledge; (c) the augmentation of the stock of knowledge; and (d) the application of knowledge. In this case, since preservation of knowledge is a major objective, activities (or "programs") such as libraries and museums would be central and development of direct measures of output or benefit would be of high priority.

Another view of the university could be that it is a service industry responsive to consumer demand--consumers in this case being students and the public. The university should act, under this concept, as a kind of giant intellectual smorgasboard, offering those courses and research projects and public service activities that customers request. In this case, clearly, enrollment and revenues would be much more proximate indicators of output or benefit than under alternative conceptualizations.

A third view, also economic in nature, would characterize the university as a producer of capital goods--albeit human capital. Here the university has the mission of providing a positive, planned contribution to the economic development of society. Satisfaction of trained manpower needs by type and the generation of knowledge in specific fields now become dominant objectives with related and reasonably straightforward measures of output. In fact, ultimate measures of benefit become at

least theoretically possible in the sense that all activities are aimed at increased levels of economic productivity.

A fourth view, and perhaps the most traditional one, sees the university as a source of instructional, research, and public services. It is a relatively bland characterization, somewhat vague, but having the virtue of a fair measure of general acceptance and the capability of accommodating some of the more interesting features of the other conceptualizations. While it leaves the problem of output measurements least well defined, its generality makes it a convenient analytic point of departure and it will be used as the basis for the balance of this discussion.

In this context it may be useful to consider a statement from the University of California's description of its basic outputs:

> The University's outputs of primary interest are educated persons including trained professional manpower, basic and applied research findings, and a variety of specialized services to the public. These are generated by the University's three major programs--Instruction, Research and Public Service--individually and in combination. Although each major program is necessary to produce the outputs of the university, no one in itself is sufficient to satisfy fully and efficiently the totality of these goals. Therefore, the analytical and managerial process for maximizing the effectiveness of the University requires a thorough understanding of the interactions among the programs as well as the costs and attributes of each of the programs. Vital to such an analysis is the consideration of the marginal costs and benefits of the many elements within each of the programs and the trade-offs among the major programs.

THE INSTITUTIONAL PROCESS AND MEASURES OF OBJECTIVE ACHIEVEMENT

However, as indicated at the outset of this paper, only the objectives and related output measures of the instructional process will be considered. This bit of analytic sub-optimization is undertaken consciously and with a knowledge of the risks involved. Higher education in general and universities

in particular are notorious for being joint-output enterprises. The arbitrary segregation of the instructional process from research for the purposes of analysis may well lead to a less complete, or worse, less valid, understanding of both the instructional and the research functions and it certainly tends to obscure their interaction. For example,

> . . . it has been hypothesized that the total costs incurred in operating equivalent instructional and research programs independently would be greater than those resulting from a combined and mutually supporting program of research and instruction operated within a single institution such as a major university. *A priori*, it would appear that the research activities have important spill-over cost-reducing effects on the graduate instruction function while concurrently the availability of the high-talent, low-cost manpower resource represented by graduate student economizes the conduct of the research projects themselves.[1]

Nevertheless, despite the risks it appears useful to take up the instructional function alone and to attempt to deal with its measures of effectiveness and output with greater detail and specificity. In doing so, adoption of a definitional convention regarding the terms "effectiveness," "output," "benefit," and "efficiency" may be useful.

Effectiveness

As used here, "effectiveness" is taken to mean a measure of how much of a given discrete increment of factual or conceptual material is transferred or added to a student. (Often this is converted to a rate measurement since some notion of increments of knowledge per unit of time is implied.) This kind of measure is peculiar to educational systems and is typically scaled, more or less well, by formal tests of various kinds. These test themselves can be of two kinds: (1) those purely internal to

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[1] From the "University of California Budget Submission," of April 4, 1969.

the institution and hence of local value only; and (2) those standardized on some much larger population which provides a quasi-objective scale of economic achievement (which can be thought of as information-bit and concept possession). The tests themselves, of course, measure only achieved levels, and it is the difference in levels of achievement over time which measure instructional program effectiveness.[2]

Output

"Output," on the other hand, may be thought of as an extension of the notion of effectiveness. Output is measured by the number of inputed units (students) which become final products by virtue of having accumulated some specified minimum number of effectiveness measures. In addition to the question of the number of such blocks of fact/concept (credits or courses required to graduate) which are used to define a unit of output, there are also questions of: (a) the size of the increment of fact/concept transferred; (b) the absolute level of fact/concept mastery reached; (c) the balance among facts, concepts, and attitudes required; and (d) the diversity, depth, and integration of the fact/concept blocks required in order to be considered a unit of output.

Point (a) above is important in the context of the notion of "value added," whereas points (b), (c), and (d) relate to the "quality" of output and are functions of the rigor of the curriculum and the vigor with which it is enforced.

Outputs may then be viewed as curriculum-completers (i.e., achievers of some "natural" culmination point in the effectiveness-block acquisition

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[2]See F. E. Balderston, Instructional Objectives and Results, a forthcoming monograph in the Ford Foundation series from the University of California.

process), counted in simple numerical fashion with some index of "quality" as between individuals in the same institution and as between the averages among different institutions. Essentially, therefore, output is measured by an inward-looking set of criteria which attempts to gauge the number, kind, and quality of degree winners or curriculum-completers based on scholarly-intellectual levels of achievement at the point of degree award.

Specific indicators of value added and quality of output would include, therefore, standardized test scores at entrance and exit points from higher education (e.g., CEEB and Graduate Record Exams), personality and attitude inventories, scholarly awards, and acceptance rates into "good" graduate schools.

Benefits

Measures of "benefits" (as opposed to those of effectiveness and output) can now be thought of as the longer term assessment of the quantity and quality of outputs using external, less academic, more total measures of the economic, social, and personal attributes of alumni. In this case, items such as the following might be thought to be good proxy measures of the benefits of the instructional program:

(a) first offered wage;
(b) cumulative income (over 5, 10, 15 years);
(c) proportion into management level (by 5th or 10th year);
(d) number of papers published in scholarly or technical journals;
(e) rate of election to select professional groups or posts;
(f) proportion teaching in select schools;
(g) rate of award of civic and professional honors;
(h) proportions holding governmental posts of significant responsibility;
(i) proportion holding elective office;
(j) voting frequency;

(k) rate of participation in local civic affairs (fund drive chairmenship, Boy Scout Leadership posts, etc.);
(l) drunkeness, arrest, and divorce rates;
(m) book and magazine reading frequency;
(n) personal evaluations of intellectual and social satisfaction.

Of course some considerable experimental work would be required to develop reliable and valid ways of gathering, evaluating, and quantifying data relevant to the indicators listed above. (For example, some recognition might have to be given to the effect of post-graduation environment.) But the task appears no more formidable than that of measuring benefits in, say, defense activities. There, the cumulative results of 10 to 15 years of intellectual investment have yielded results which appear to make effectiveness, output, and benefit measures a simple matter. In truth they are and remain complex problems, but the analysts have come to terms with some of their problems and have learned to live with sets of proxies which are, in total, deemed to approximate real objective-achievement. After all, if deterrence is the objective of the strategic nuclear forces, how is it to be measured? Is it not essentially a state of mind among a select group of Soviet officials? And that surely is difficult to measure directly--much more so than the qualities of mind of persons available to us and generally willing to disclose facts about themselves.

Efficiency and the Notion of Value Added

Given the above conventions as to what constitutes effectiveness, output, and benefit, how can we define "efficiency?" Efficiency was described earlier, somewhat loosely, as cost per unit of output. Clearly that definition needs to be amended in several directions. At the least,

it should be amended to read "cost per unit of output of a particular kind (e.g., B.S. in E.E.) and at a specified quality level." Further, costs should be related not only to the narrowly defined, inward-looking, measures of output, but to the larger and more objective ones characterizing benefits as well.

But even this is not enough for an adequate measure of efficiency. A substantial amount of research indicates that quality of output is strongly related to quality of student inputs.[3] The old observation that Harvard may be the worst school in the country--it is impossible to tell how good Harvard really is--is to the point. Simply because Harvard graduates gain a disproportionately large share of the world's honors says as much for the kind of people admitted as it does for what Harvard did for them. If an institution takes from among the top 1 percent of the nation's secondary school graduates, it is pretty difficult not to turn out the top 1 percent of the nation's college graduates.

To have some idea of what the institution did to its students, it is essential to know their condition at the time of their admission as well as when they graduated. In this way some credible measure of value added can be achieved; and it is, properly, cost per unit of value added which should be used as a test of efficiency.

Obviously, if an institution for one reason or another is taking in a student population below the mean (of some postulated comparison group) in terms of secondary school achievement levels and socio-economic background and is producing outputs (i.e., graduating B.A.'s) at the seventy-fifth percentile--and is doing it at a unit cost equal to that of the

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[3] See especially Lewis J. Perl and Martin T. Katzman, Student Flows in California's System of Higher Education (Berkeley: University of California, n.d.).

average of the other institutions--then clearly it is an efficient instructional institution even though the absolute quality level of its outputs is not up to that of the leading institutions. The notion of value added also makes it simpler, at least conceptually, to deal with the problem of evaluating non-degree-winning students. In this case, all students who leave the system can be considered units of output, and their partial value added can be integrated with that of the regular degree winners to get a measure of total output or benefit to compare with total costs.

Furthermore, all kinds of interesting cost/benefit analyses become possible using this approach. For example, what is the marginal productivity in terms of value added if a given amount of resources is invested: (a) in the first two years of a four-year program; (b) in the second two years; (c) on potential dropouts; (d) on actual dropouts; (e) on high aptitude students; (f) on low aptitude students; and (g) on applicants before they come to a four-year institution. And for each of these groups there is a wide variety of particular ways in which to use the additional resources (counseling, tutoring, curriculum reform, teaching aids, faculty enrichment, living cost subsidization, remedial instruction, etc.).

In addition to the conceptual, analytic, and practical problems of attempting to measure value added, there is an extremely thorny public issue involved. Cost per unit of value added may indeed be a valid measure of institutional instructional effectiveness, but there remains the problem of what choice to make if, despite a large increment of value or benefit added, the absolute quality of outputs is below some desired minimum level. A similar problem would exist if it turned out that substantially larger increments of value added can be achieved for a given investment by concentrating them on some target group, for example,

students of very high or very low academic achievement. Under these circumstances, undoubtedly some mixed policy would have to be adopted, and narrow notions of pure instructional efficiency would have to be considerably tempered.[4]

Clearly, in the context of the above discussion, figures of merit implying efficiency such as cost per student credit hour are almost useless--and may well be downright misleading. A simple first step (of assistance at least in planning and budgeting) would be to calculate annual costs of instruction per student by level and subject field major. If these data were combined with persistence and attrition information from a student flow model, then costs per degree winner at a given quality level can be calculated. If these are further controlled for quality of student inputs and for partial outputs--and for external measures of benefits--then something like total costs and total benefits can be compared and a crude judgment reached about relative efficiency.

Valid and satisfying analysis of this kind is some distance in the future--although it is better to sweat out partial answers to the right questions than to get immediate answers to the wrong ones. (Alain Enthoven's first commandment for analysts was: "Better crudely right than precisely wrong."). In the meantime, it may be useful to pursue some less satisfying comparative measures. The following sections attempt to describe a way in which the indices of benefit listed earlier could be used by administrators to get some rough idea of whether their institutions are doing a good or bad job in the instructional process.

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[4]See Balderston, op.cit., for a more complete discussion of this problem.

AN ANALYTIC COMPARISON SYSTEM FOR MEASURING INSTRUCTIONAL EFFICIENCY

It may be helpful to begin by trying to clarify the various comparisons which often have to be made. First, there is the question of the total cost (personal, including foregone wages; institutional; and state) and total benefits (private and public, economic and non-economic) which result from instruction in a particular field, in a given institution, as among degree programs at various levels (B.A., M.A., Ph.D.). A common way of analyzing this problem is to compare the discounted present value of marginal costs and increments to lifetime income resulting from a particular degree program and calculate a rate of return (or more properly, an expected value of the rate of return) on the investment. The problem here, of course, is that implicitly public returns are equated with private ones, and seriously inadequate attention is paid to the non-economic or less measurable benefits of advanced degree work.

A second area of comparison concerns degree work at a given level within a given institution, but covering different fields. The same mode of analysis as described above is sometimes employed, but it is obviously even less applicable for these kinds of comparisons. All of the cautions noted above must be taken into account, as well as the need for some idea of the desired future stocks of manpower by type, in order to have a socially, culturally, and economically healthy society.

Ignoring for the moment questions of relative benefits by field, some provocative analysis is possible on just the cost aspects of various outputs. For example, using a cost simulation model for the Berkeley campus, costs per student per year by discipline and level were determined. These show roughly a 6:1 range between the highest and lowest disciplines at a

given level, with the humanities at the low end and engineering close to the top. However, when these costs were applied to cohorts of graduate students segregated into various disciplines and the total institutional instructional system costs per Ph.D. produced were calculated, the ranking by annual cost of instruction almost exactly reversed itself. In fact, the cost per unit of output (i.e., Ph.D. winner) for the humanities was about 50 percent higher than it was for engineering. Thus, without any judgment about the relative benefits associated with degree winners in each of those fields, it is clear that the cost patterns are quite different. At least this would suggest a close examination of the production function in the humanities and some analysis of the marginal productivity (in terms of additional degree winners) from additional investments in graduate student assistance of various kinds, curriculum reform, etc.

The third basis of comparison, and the one of perhaps greatest interest and manageability, is that of cost per unit of output for degree winners at the same level and in the same field, but as among institutions. Here a careful and consistent treatment of costs combined with a numerical counting of outputs (degree winners), plus an evaluation of their quality using the benefit indices listed earlier, could yield useful clues on instructional efficiency and the effectiveness of alternative remedial techniques.

This quasi-analytic comparison system might operate in the following fashion:

(1) Each of a large group of cooperating institutions would undertake to explicate their instructional objectives by weighting (to a total of 1.0) the 14 or so measures of benefit above in accordance with their own institutional value system. They would do this for

each of their degree programs in each major field. Thus a school like Cal Tech might, for example, put the heaviest weights on first offered wage (.2), cumulative first five years' wages (.3), advancement to management (.2), and professional honors (.1), and distribute the remainder among the other indices. Harvard, on its part, for its liberal arts undergraduates might put much less weight on the economic and professional honors benefit indices and put heavier weights on items such as governmental posts of responsibility, teaching, and civic participation rates. And a school such as Reed might shift the emphasis even more and weight very heavily the measures of personal achievement and satisfaction. (A separate set of criteria, or at least a different set of weights, might be necessary for female students; and the treatment of intellectual and social satisfaction will always pose difficult problems of evaluation.)

In any event, each institution would develop a set of weights for their degree programs by level and discipline, reflecting their valuation of various benefit or quality characteristics, and these would all be entered in a central data bank. Then via a computerized, peer group matching routine each institution would be furnished a 10 or 15 institution peer group for each of its major degree programs based on similarity of quality index weightings.

(2) Each of the institutions in each of the peer groups would then undertake to gather consistent cost data on its outputs at that level and in that field (a function the WICHE MIS project is admirably aimed to facilitate!) and on empirical measures of the 14 or so quality indices. This could be done both retrospectively via carefully chosen, stratified random sample surveys of alumni

and on an ongoing basis for current degree winners.

(3) As a result of developing these data it would then be possible to rank the 10 to 15 members of each peer group on a unit cost and on a weighted, average quality index basis. This would provide single-point-in-time estimates of where an institution stood relative to a group with roughly similar objectives; and over time it would provide evidence on whether an institution was moving up or down within the peer group.

CONCLUSION

It might very well turn out that there was a determinable relationship between resources invested (unit costs) and quality of output (weighted, average quality index). The form of this relationship would then be of very great interest in that all of the institutions would have some rough idea of the cost of changing their output quality indices. Where there were inversions between unit costs and quality indices, the institution could begin a profitable series of analyses aimed at discovering the causes of their relatively poor performance. These could focus initially on the four main possibilities: (1) high annual costs of instruction per student; (2) low persistence rates to the degree; (3) inadequate curricula or standards; or (4) a different kind of student input in terms of academic achievement, motivation, socio-economic background, etc. The first three of these factors concern variables under the control of the institution, while the last is either only partly so or not at all.

Obviously, the present state of the analytic art and data availability would make precise analyses and fully controlled comparisons impossible;

but surely some greater understanding of the real nature of outputs and their costs, and the interactions between them, would emerge from the attempt at more quantitative and formalized analysis as described above.

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